

Marine fishes from Galicia (NW Spain): an updated checklist

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Abstract

An annotated checklist of the marine fishes from Galician waters is presented. The list is based on historical literature records and new revisions. The ichthyofauna list is composed by 397 species very diversified in 2 superclass, 3 class, 35 orders, 139

families and 288 genus. The order Perciformes is the most diverse one with 37 families, 91 genus and 135 species. Gobiidae (19 species) and Sparidae (19 species) are the richest families. Biogeographically, the Lusitanian group includes 203 species (51.1%), followed by 149 species of the Atlantic (37.5%), then 28 of the Boreal (7.1%), and 17 of the African (4.3%) groups. We have recognized 41 new records, and 3 other records have been identified as doubtful. Identification and registration errors have been also indicated.

Key words: checklist, ichthyofauna, Galician waters, NE Atlantic, biogeography

Resumen

Se presenta un listado de los peces de mar de Galicia. El listado se basa en registros de publicaciones históricas y nuevas revisiones. La lista está compuesta por 398 especies, agrupadas en 2 superclases, 3 clases, 35 órdenes, 139 familias y 288 géneros. El orden Perciformes es el más diverso con 37 familias, 91 géneros y 135 especies. Gobiidae (19) y Sparidae (19) son las familias con mayor diversidad. Con respecto a la biogeografía, el grupo Lusitánico incluye 203 especies (51.1 %), seguido por 149 especies del Atlántico (37.5%), 28 del Boreal (7.1%) y 17 del Africano (4.3%). Se han reconocido 41 especies nuevas para la zona, identificado registros previos como errores de identificación o de registro y se han indicado otros 3 como dudosos.

Palabras clave: listado, ictiofauna, Galicia, Atlántico NE, biogeografía.

Introduction

1 The first list of Galician marine fishes was produced by Cornide (1788), comprising 65
2 species. Almost one century later, López-Seone (1866) elaborated a complete summary
3 of the Galician fauna and enumerated 95 species of fishes, 53 of them new. The 118
4 species described in these two pioneering works established the basis of the current
5 knowledge of the marine ichthyofauna of Galicia. During the 20th century, studies
6 concerning with any aspect of ichthyology (taxonomy, ecology, biology, fisheries, etc.)
7 re-emerged, mainly due to the establishment in Vigo of the Instituto Español de
8 Oceanografía (IEO) back in 1917, and the Instituto de Investigaciones Marinas (IIM-
9 CSIC) in 1951. The research activity, scientific publications and oceanographic and
10 fishery surveys carried out by these two institutions quickly increased the number of
11 marine fishes recorded in this region.

12 By the end of the 20th century, Galician marine ichthyofauna began to be
13 concisely inventoried. Solórzano *et al.* (1983), in the first modern study of Galician
14 marine fishes, listed 265 species, being most of them littoral ones. Years later,
15 Solórzano *et al.* (1988) increased this number up to 296 species. Piñeiro *et al.* (1996)
16 and Bañón (2002) updated the checklist with 46 more new species, most of them from
17 deep waters, establishing in 342 the number of total known species. Subsequent records
18 and reviews enlarged this number up to 357 (Bañón, 2009), what is the last update until
19 the publication of the present work.

20 In the present paper, an annotated list of the marine fishes of Galicia, including
21 42 new records, is provided. The main new data sources included in this study have
22 their origin in two historical series: the annual demersal trawl surveys carried out by the
23 Instituto Español de Oceanografía (IEO), since 1983, and the monitoring program of
24 artisanal fisheries carried out by the regional Government (Xunta de Galicia) since
25 1999.

1

2 **Study area and Methods**

3 Galicia is an autonomous region of Spain located in the north-western corner of
4 the Iberian Peninsula, between the river Eo (43° 32' N, 7° 01' W) and the river Miño
5 (41° 50' N, 9° 40' W) (Figure 1). The Galician coast has a length of 1,195 km,
6 representing 35% of the Spanish coastline. The study area comprises the continental
7 shelf and the slope of Galician waters including some abyssal zones and the Galicia
8 Bank. The Galicia Bank is a deep seamount off the continental shelf, at about 42° 8' N –
9 11°8' W with depths ranging from 650 in its summit to more than 1500 m. The Galician
10 shelf is relatively narrow with a maximum width of 35 km. Galicia is located in the
11 limit of the Eastern North Atlantic Upwelling System. Upwelling favourable winds
12 prevail from March to October and cause the entry of great flows of salty cold water
13 (Álvarez-Salgado et al., 1993).

14 We have adopted Ellis et al. (2007) in the attribution of biogeographic affinity
15 categories: Boreal, Lusitanian (including Mediterranean species), Atlantic (including
16 deep-water or mesopelagic species widely distributed) and African.

17 Specimens presented in the collection of the Museo de Ciencias Naturales Luís
18 Iglesias de Santiago de Compostela Historia Natural have been marked by one asterisk
19 (*). Additional material deposited in the Colección Ictiológica de Referencia (CIR) of
20 the Instituto de Ciencias del Mar-CSIC de Barcelona have been indicated by two
21 asterisks (**). Previous revisions of fish fauna from NE Atlantic made by Whitehead et
22 al. (1986) and Quéro et al. (2003) have been used in the discussion of the data regarding
23 the geographical distribution.

The checklist is presented in the taxonomic sequence: superclass, class, order, family, genus and species. We have followed Quéro et al. (2003) for the classification system order and Froese and Pauly (2010) for the scientific nomenclature and common names.

Results

SUPERCLASS AGNATHA

CLASS CEPHALASPIDOMORPHA

ORDER PETROMYZONTIFORMES

Family Petromyzontidae

**Petromyzon marinus* Linnaeus, 1758 — Sea lamprey

SUPERCLASS GNATHOSTOMATA

CLASS CHONDRICHTHYES

ORDER HEXANCHIFORMES

Family Hexanchidae

Hexanchus griseus (Bonnaterre, 1788) — Bluntnose sixgill shark

Family Chlamydoselachidae

**Chlamydoselachus anguineus* Garman, 1884 — Frilled shark

- 1 ORDER SQUALIFORMES
- 2 Family Echinorhinidae
- 3 *Echinorhinus brucus* (Bonnaterre, 1788) — Bramble shark
- 4 Family Squalidae
- 5 *Squalus acanthias* Linnaeus, 1758 — Piked dogfish
- 6 *Squalus blainvillei* (Risso, 1827) — Longnose spurdog
- 7 Family Centrophoridae
- 8 *Centrophorus granulosus* (Bloch & Schneider, 1801) — Gulper shark
- 9 *Centrophorus squamosus* (Bonnaterre, 1788) — Leafscale gulper shark
- 10 *Deania calcea* (Lowe, 1839) — Birdbeak dogfish
- 11 *Deania hystricosa* (Garman, 1906) — Rough longnose dogfish
- 12 Not mentioned for Galicia by McEachran and Branstetter in Whitehead *et al.* (1986) nor
- 13 Quéro *et al.* (2003). One record for Galicia based on an unreported specimen from
- 14 Galicia Bank.
- 15 Family Etmopteridae
- 16 **Etmopterus spinax* (Linnaeus, 1758) — Velvet belly lantern shark
- 17 *Etmopterus princeps* Collett, 1904 — Great lanternshark
- 18 *Etmopterus pusillus* (Lowe, 1839) — Smooth lanternshark
- 19 Family Somniosidae

- 1 *Centroscymnus coelolepis* Barbosa du Bocage & de Brito Capello, 1864 — Portuguese
2 dogfish.
- 3 *Centroselachus crepidater* (Barbosa du Bocage & de Brito Capello, 1864) — Longnose
4 velvet dogfish.
- 5 *Scymnodon ringens* Barbosa du Bocage & de Brito Capello, 1864 — Knifetooth dogfish
- 6 *Somniosus rostratus* (Risso, 1827) — Little sleeper shark
- 7 Family Oxynotidae
- 8 *Oxynotus centrina* (Linnaeus, 1758) — Angular roughshark
- 9 *Oxynotus paradoxus* Frade, 1929 — Sailfin roughshark
- 10 Family Dalatiidae
- 11 *Dalatias licha* (Bonnaterre, 1788) — Kitefin shark
- 12
- 13 ORDER SQUATINIFORMES
- 14 Family Squatinidae
- 15 *Squatina squatina* (Linnaeus, 1758) — Angelshark
- 16
- 17 ORDER LAMNIFORMES
- 18 Family Lamnidae
- 19 *Lamna nasus* (Bonnaterre, 1788) — Porbeagle

- 1 *Carcharodon carcharias* (Linnaeus, 1758) — Great white shark
- 2 Reported by Solorzano *et al.* (1988) based on specimens discharged at the Coruña
- 3 fishmarket, caught by the long line fleet. We consider this a doubtful record, because
- 4 those specimens were probably caught out of the study area.
- 5 *Isurus oxyrinchus* Rafinesque-Schmaltz, 1810 — Shortfin mako
- 6 Family Cetorhinidae
- 7 *Cetorhinus maximus* (Gunnerus, 1765) — Basking shark
- 8 Family Alopiidae
- 9 *Alopias vulpinus* (Bonnaterre, 1788) — Thintail thresher
- 10 *Alopias superciliosus* (Lowe, 1841) — Bigeye thresher
- 11 Common species in the open North Atlantic but with a single record from Galicia: a
- 12 male specimen stranded in Playa América, Nigrán (Pontevedra), in July 2008
- 13 (CEMMA, personal communication).
- 14 Family Scyliorhinidae
- 15 **Galeus melastomus* Rafinesque, 1810—Blackmouth catshark
- 16 *Galeus atlanticus* (Vaillant, 1888)—Atlantic sawtail cat shark
- 17 Not mentioned for Galician waters neither in Whitehead *et al.* (1986) nor in Quéro *et al.*
- 18 (2003). Frequently caught between 400 and 711 m depth during the last years in the
- 19 “Demersales” surveys. Probably this species was previously confused with *G.*
- 20 *melastomus*.

- 1 **Scyliorhinus canicula* (Linnaeus, 1758)—Small-spotted catshark
- 2 *Scyliorhinus stellaris* (Linnaeus, 1758) —Nursehound
- 3 Family Pseudotriakidae
- 4 *Pseudotriakis microdon* de Brito Capello, 1868 — False catshark
- 5 Recorded for Galicia based on unreported specimens from the Galicia Bank (Figure 2).
- 6 Family Carcharhinidae
- 7 **Galeorhinus galeus* (Linnaeus, 1758) — Tope shark
- 8 *Mustelus mustelus* (Linnaeus, 1758) — Smooth-hound
- 9 *Mustelus asterias* Cloquet, 1821 — Starry smooth-hound
- 10 *Prionace glauca* (Linnaeus, 1758) — Blue shark
- 11 Family Sphyrnaeidae
- 12 *Sphyrna zygaena* (Linnaeus, 1758) — Smooth hammerhead
- 13
- 14 ORDER TORPEDINIFORMES
- 15 Family Torpedinidae
- 16 *Torpedo torpedo* (Linnaeus, 1758) — Common torpedo
- 17 **Torpedo marmorata* Risso, 1810 — Spotted torpedo
- 18

- 1 ORDER RAJIFORMES
- 2 Family Rhinobatidae
- 3 *Rhinobatos rhinobatos* (Linnaeus, 1758) — No common name
- 4 *Rhinobatos cemiculus* Geoffroy Saint-Hilaire, 1817—Blackchin guitarfish
- 5 Family Rajidae
- 6 *Raja miraletus* Linnaeus, 1758— Brown ray
- 7 *Raja asterias* Delaroche, 1809— Starry ray
- 8 *Raja brachyura* Lafont, 1873—Blonde ray
- 9 **Raja clavata* Linnaeus, 1758—Thornback ray
- 10 **Raja microocellata* Montagu, 1818—Small-eyed ray
- 11 **Raja montagui* Fowler, 1910—Spotted ray
- 12 *Dipturus batis* (Linnaeus, 1758) — Blue skate
- 13 *Dipturus oxyrinchus* (Linnaeus, 1758) — Longnosed skate
- 14 *Leucoraja circularis* (Couch, 1838) — Sandy ray
- 15 *Leucoraja naevus* (Müller & Henle, 1841) — Cuckoo ray
- 16 *Rostroraja alba* (Lacepède, 1803) — Bottlenosed skate
- 17 **Raja undulata* Lacepède, 1802 — Undulate ray
- 18 Family Dasyatidae

- 1 *Dasyatis pastinaca* (Linnaeus, 1758) — Common stingray
- 2 ***Pteroplatytrygon violacea* (Bonaparte, 1832) — Pelagic stingray
- 3 Not mentioned for Galicia by McEachran and Capapé in Whitehead *et al.* (1986).
- 4 Recorded from the Galicia Bank under the name of *Dasyatis violacea* (Bañón *et al.*
- 5 1997).
- 6 Family Myliobatidae
- 7 **Myliobatis aquila* (Linnaeus, 1758) — Common eagle ray
- 8 *Mobula mobular* (Bonnaterre, 1788) — Devil fish
- 9
- 10 **CLASS HOLOCEPHALI**
- 11 **ORDER CHIMAERIFORMES**
- 12 Family Chimaeridae
- 13 **Chimaera monstrosa* Linnaeus, 1758 — Rabbit fish
- 14 *Hydrolagus mirabilis* (Collet, 1904) — Large-eyed rabbitfish
- 15
- 16 **CLASS ACTINOPTERYGII**
- 17 **ORDER NOTACANTHIFORMES**
- 18 Family Halosauridae
- 19 *Halosaurus ovenii* Johnson, 1864 — No common name

- 1 Not mentioned for Galicia by Sulak in Whitehead *et al.* (1986). Recorded from Galicia
- 2 by Bañón *et al.* (1997): 13 specimens caught between 769 and 1139 m depth.
- 3 *Halosauropsis macrochir* (Günther, 1878) — Abyssal halosaur
- 4 *Aldrovandia phalacra* (Vaillant, 1888) — Hawaiian halosaurid fish
- 5 Family Notacanthidae
- 6 **Notacanthus bonaparte* Risso, 1840 — Shortfin spiny eel
- 7 *Notacanthus chemnitzii* Bloch, 1788 — Spiny eel
- 8
- 9 ORDER ANGUILLIFORMES
- 10 Family Anguillidae
- 11 **Anguilla anguilla* (Linnaeus, 1758) — European eel
- 12 Family Muraenidae
- 13 *Muraena helena* Linnaeus, 1758 — Mediterranean moray
- 14 Family Synphobranchidae
- 15 *Synphobranchus kaupii* Johnson, 1862 — Kaup's arrowtooth eel
- 16 Family Ophichthidae
- 17 *Ophisurus serpens* (Linnaeus, 1758) — Serpent eel
- 18 *Pisodonophis semicinctus* (Richardson, 1848) — Saddled snake eel

- 1 Not mentioned for the Atlantic European waters by Bauchot in Whitehead *et al.* (1986).
- 2 Recorded from Galicia by Bañón *et al.*, (2002) (figure 3).
- 3 Family Congridae
- 4 **Conger conger* (Linnaeus, 1758) — European conger
- 5 Family Nemichthyidae
- 6 *Nemichthys scolopaceus* Richardson, 1848 — Slender snipe eel
- 7 Family Serrivomeridae
- 8 *Serrivomer beanii* Gill & Ryder, 1883 — Bean's sawtoothed eel
- 9 Family Nettastomatidae
- 10 *Nettastoma melanurum* Rafinesque, 1810 — Blackfin sorcerer
- 11 Not mentioned for Galicia by Saldanha in Whitehead *et al.* (1986). Recorded by Bañón
- 12 *et al.* (1997) based on six specimens caught between 806 and 1139 m depth.
- 13 *Facciolella oxyrhyncha* (Bellotti, 1883) — Facciola's sorcerer
- 14 Recorded for Galicia based on a specimen of 56 cm TL caught during the survey
- 15 “Demersales 06” at 436 m depth.
- 16 ORDER SACCOPHARYNGIFORMES
- 17 Family Eurypharyngidae
- 18 *Eurypharynx pelecánoides* Vaillant, 1882 — Pelican eel
- 19

- 1 ORDER CLUPEIFORMES
- 2 Family Cupleidae
- 3 **Sardina pilchardus* (Walbaum, 1792) — European pilchard
- 4 *Alosa fallax* (Lacepède, 1803) — Twaite shad
- 5 *Alosa alosa* (Linnaeus, 1758) — Allis shad
- 6 **Sprattus sprattus* (Linnaeus, 1758) — European sprat
- 7 Family Engraulidae
- 8 *Engraulis encrasicolus* (Linnaeus, 1758) — European anchovy
- 9
- 10 ORDER OSMERIFORMES
- 11 Family Argentinidae
- 12 **Argentina sphyraena* Linnaeus, 1758 — Argentine
- 13 **Argentina silus* (Ascanius, 1775) — Greater argentine
- 14 Family Alepocephalidae
- 15 *Alepocephalus rostratus* Risso, 1820 — Risso's smooth-head
- 16 *Alepocephalus bairdii* Goode & Bean, 1879 — Baird's smooth-head
- 17 **Xenodermichthys copei* (Gill, 1884) — Bluntsnout smooth-head
- 18 Family Platytrichtidae

- 1 *Holtbyrnia macrops* Maul, 1957— Bigeye searsid
- 2 Recorded for Galicia based on two specimens caught at 680 m depth during the survey
- 3 “Demersales 96”.
- 4 *Mentodus rostratus* Günther, 1878 — No common name
- 5
- 6 ORDER SALMONIFORMES
- 7 Family Salmonidae
- 8 **Salmo trutta* Linnaeus, 1758 — Sea trout
- 9 **Salmo salar* Linnaeus, 1758 — Atlantic salmon
- 10
- 11 ORDER STOMIIFORMES
- 12 Family Gonostomatidae
- 13 *Sigmops bathyphilus* (Vaillant, 1884) — Spark anglemouth
- 14 *Gonostoma elongatum* Günther, 1878 — Elongated bristlemouth fish
- 15 *Cyclothone braueri* Jespersen & Tåning, 1926 — Garrick
- 16 *Cyclothone microdon* (Günther, 1878) — No common name
- 17 Family Sternoptychidae
- 18 *Sternoptyx diaphana* Hermann, 1781 — Diaphanous hatchet fish
- 19 *Argyropelecus hemigymnus* Cocco, 1829 — Half-naked hatchetfish

- 1 **Argyropelecus olfersii* (Cuvier, 1829) — No common name
- 2 *Argyropelecus aculeatus* Valenciennes, 1850 — Lovely hatchetfish
- 3 Recorded for Galicia based on a single specimen of 7 cm TL caught during the survey
- 4 “Demersales 07”.
- 5 *Argyropelecus gigas* Norman, 1930 — Hatchetfish
- 6 Recorded for Galicia based on four specimens between 7-9 cm TL caught during
- 7 “Demersales 83 and 91” surveys
- 8 **Maurolicus muelleri* (Gmelin, 1789) — Pearlsides
- 9 Family Phosichthyidae
- 10 *Vinciguerria poweriae* (Cocco, 1838) — Power's deep-water bristle-mouth fish
- 11 *Ichthyococcus ovatus* (Cocco, 1838) — Lightfish
- 12 Recorded for Galicia based on one specimen of 4 cm TL caught during the survey
- 13 “Demersales 03”
- 14 *Polymetme corythaeola* (Alcock, 1898) — Rendezvous fish
- 15 Family Stomiidae
- 16 *Rhadinesthes decimus* (Zugmayer, 1911) — Slender snaggletooth
- 17 **Stomias boa* (Risso, 1810) — Scaly dragonfish
- 18 *Chauliodus sloani* Bloch & Schneider, 1801 — Sloane's viperfish
- 19 *Leptostomias gladiator* (Zugmayer, 1911) — No common name

- 1 *Melanostomias bartonbeani* Parr, 1927 — Scaleless black dragonfish
- 2 Recorded for Galicia based on one specimen of 16 cm TL caught at 688 m depth during
- 3 the survey “Demersales 08”
- 4
- 5 ORDER ATELEOPODIFORMES
- 6 Family Ateleopodidae
- 7 *Ijimaia loppei* Roule, 1922 — Loppe's tadpole fish
- 8
- 9 ORDER AULOPIFORMES
- 10 Family Chlorophthalmidae
- 11 **Chlorophthalmus agassizi* Bonaparte, 1840 — Shortnose greeneye
- 12 Family Ipnopidae
- 13 *Bathypterois dubius* Vaillant, 1888 — Spiderfish
- 14 Family Paralepididae
- 15 *Arctozenus risso* (Bonaparte, 1840) — Ribbon barracudina
- 16 *Paralepis coregonoides* Risso, 1820 — Sharpchin barracudina
- 17 Recorded for Galicia based on three specimens of 16-20 cm TL caught between 360-
- 18 564 m depth during the surveys “Demersales 83, 03 and 08”
- 19 Family Alepisauridae

- 1 *Alepisaurus ferox* Lowe, 1833 — Longnose lancetfish
- 2 *Sudis hyalina* Rafinesque, 1810 — No common name
- 3
- 4 ORDER MYCTOPHIFORMES
- 5 Family Neoscopelidae
- 6 *Neoscopelus macrolepidotus* Johnson, 1863 — Large-scaled lantern fish
- 7 Not mentioned for Galicia by Hulley in Whitehead *et al.* (1986). Recorded from Galicia
- 8 by Bañón *et al.* (2002).
- 9 ***Neoscopelus microchir* Matsubara, 1943 — No common name
- 10 Not mentioned for Galicia by Hulley in Whitehead *et al.* (1986). Recorded from the
- 11 Galicia Bank by Bañón *et al.* (1997).
- 12 Family Myctophidae
- 13 *Myctophum punctatum* Rafinesque, 1810 — Spotted lanternfish
- 14 *Diaphus dumerilii* (Bleeker, 1856) — No common name
- 15 Recorded for Galicia based on 10 specimens between 4-8 cm TL caught at 365-563 m
- 16 depth during “Demersales 97 and 06” surveys
- 17 *Ceratoscopelus maderensis* (Lowe, 1839) — No common name
- 18 *Ceratoscopelus warmingii* (Lütken, 1892) — No common name

Uncertain status. Reported by Hulley in Whitehead *et al.* (1986) to south of 35°N; it is unreported by Quéro *et al.* (2003). Recorded for Galicia by Lozano y Rey (1947) as *Lampanyctus townsendi*, a synonym of *C. warmingii*. A revision of new specimens is needed.

Lampadena urophaos atlantica Maul, 1969 — No common name

Uncertain status. Not mentioned for Galicia neither by Hulley in Whitehead *et al.* (1986) nor by Quéro (2003). Recorded from Galicia by Arté (1952) and Anadón (1957) as *L. nitida*. Questionable as a synonym of *L. urophaos atlantica* (Solórzano *et al.*, 1988). A revision of new specimens is required.

Lampadena speculigera Goode & Bean, 1896 — Mirror lanternfish

Recorded for Galicia based on a specimen of 4 cm TL caught at 228 m depth during the survey “Demersales 93”

Lampanyctus crocodilus (Risso, 1810) — Jewel lanternfish

Lampanyctus photonotus Parr, 1928 — No common name

Lampanyctus intricarius Taning, 1928 — No common name

Recorded for Galicia based on a single specimen of 17 cm TL caught during the survey “Demersales 02”

Notoscopelus kroeyeri (Malm, 1861) — Lancet fish

Reported from Galicia by Solórzano *et al.* (1988) as *N. elongatus*.

Benthoosema glaciale (Reinhardt, 1838) — Glacier lanternfish

- 1 ORDER LAMPRIFORMES
- 2 Family Trachipteridae
- 3 *Trachipterus arcticus* (Brünnich, 1788) — Deal fish
- 4
- 5 ORDER GADIFORMES
- 6 Family Macrouridae
- 7 *Gadomus longifilis* (Goode & Bean, 1885) — Treadfin grenadier
- 8 **Trachyrincus scabrus* (Rafinesque, 1810) — Roughsnout grenadier
- 9 *Hymenocephalus italicus* Giglioli, 1884 — Glasshead grenadier
- 10 *Coelorinchus caelorinchus* (Risso, 1810) — Hollow nosed rattail
- 11 Occasional catches mainly between 300-650 m depth in various “Demersales” surveys
- 12 *Coelorinchus labiatus* (Koelher, 1896) — Spearsnouted grenadier
- 13 Reported from Galicia as *C. vaillanti* by Arté (1952).
- 14 *Coryphaenoides rupestris* Gunnerus, 1765 — Roundhead rat-tail
- 15 *Cetonurus globiceps* (Vaillant, 1884) — Globehead grenadier
- 16 **Malacocephalus laevis* (Lowe, 1843) — Rough rat-tail
- 17 **Nezumia aequalis* (Günther, 1878) — Common Atlantic grenadier
- 18 *Nezumia sclerorhynchus* (Valenciennes, 1838) — Roughtip grenadier

- 1 Family Moridae
- 2 *Antimora rostrata* (Günther, 1878) — Blue antimora
- 3 *Gadella maraldi* (Risso, 1810) — Gadella
- 4 Recorded for Galicia based on one specimen of 11 cm TL caught to 570 m depth during
- 5 the survey “Demersales 09”
- 6 *Halargyreus johnsonii* Günther, 1862 — Slender codling
- 7 *Physiculus dalwigki* Kaup, 1858 — Black codling
- 8 Not mentioned for Galicia by Cohen in Whitehead *et al.* (1986). Recorded from the
- 9 Galicia Bank by Bañón *et al.* (2002) (Figure 4).
- 10 *Mora moro* (Risso, 1810) — Common mora
- 11 **Lepidion eques* (Günther, 1887) — North Atlantic codling
- 12 Family Melanonidae
- 13 *Melanonus zugmayeri* Norman, 1930 — Arrowtail
- 14 Family Gadidae
- 15 **Raniceps raninus* (Linnaeus, 1758) — Tadpole fish
- 16 **Trisopterus luscus* (Linnaeus, 1758) — Bib
- 17 **Trisopterus minutus* (Linnaeus, 1758) — Poor cod
- 18 *Gadus morhua* Linnaeus, 1758 — Cod
- 19 **Micromesistius poutassou* (Risso, 1827) — Blue whiting

- 1 **Gadiculus argenteus argenteus* Guichenot, 1850 — Silvery pout
- 2 **Merlangius merlangus* (Linnaeus, 1758) — Whiting
- 3 **Pollachius pollachius* (Linnaeus, 1758) — Pollack
- 4 Family Lotidae
- 5 *Gaidropsarus macrophthalmus* (Günther, 1867) — Big-eyed rockling
- 6 *Gaidropsarus granti* (Regan, 1903) — Azores rockling
- 7 Recorded from the Galicia Bank by Bañón *et al.* (2002). Recorded again in 2009 in the
- 8 same area (Figure 5), confirming its presence. This species has never been caught in the
- 9 continental shelf of the Atlantic area and their distribution seems to be restricted to
- 10 islands and seamounts.
- 11 *Gaidropsarus guttatus* (Collet, 1890) — No common name
- 12 **Gaidropsarus vulgaris* (Cloquet, 1824) — 3-bearded rockling
- 13 **Gaidropsarus mediterraneus* (Linnaeus, 1758) — Shore rockling
- 14 **Ciliata mustela* (Linnaeus, 1758) — 5-bearded rockling
- 15 *Molva molva* (Linnaeus, 1758) — Ling
- 16 *Molva macrophtalma* (Linnaeus, 1758) — Common ling
- 17 Previously reported as *M. dypterigia* (Solórzano *et al.*, 1988)
- 18 Family Phycidae
- 19 *Phycis phycis* (Linnaeus, 1766) — Forkbeard

- 1 **Phycis blennoides* (Brünnich, 1768) — Greater forkbeard
- 2 Family Merluccidae
- 3 **Merluccius merluccius* (Linnaeus, 1758) — European hake
- 4
- 5 ORDER OPHIDIIFORMES
- 6 Family Ophidiidae
- 7 *Ophidion barbatum* Linnaeus, 1758 — Snake blenny
- 8 Family Aphyonidae
- 9 *Sciadonus cryptophthalmus* (Zugmayer, 1911) — No common name
- 10 Family Carapidae
- 11 *Carapus acus* (Brünnich, 1768) — Pearl fish
- 12 *Echiodon drummondii* Thompson, 1837 — Pearlfish
- 13 **Echiodon dentatus* (Cuvier, 1829) — No common name
- 14
- 15 ORDER LOPHIIFORMES
- 16 Family Lophiidae
- 17 *Lophius budegassa* Spinola, 1807 — Black-bellied anglerfish
- 18 **Lophius piscatorius* Linnaeus, 1758 — Anglerfish

1 Family Chaunacidae

2 *Chaunax pictus* Lowe, 1846 — Pink frogmouth

3 Family Ceratiidae

4 *Ceratias holboelli* Krøyer, 1845 — Kroyer's deep sea anglerfish

5 Recorded for Galicia based on one female of 560 mm TL (Figure 6) caught by the
6 vessel “Ría de Cedeira” on 19th December 2006 at 676 m depth in the north of Galicia
7 (“As Paredes”: 44° 07' N - 08° 07' W)

8 Family Linophryinae

9 ***Linophryne coronata* Parr, 1927 — Deep-sea anglerfish

10 Not mentioned for Galicia by Cohen in Whithead *et al.* (1986). Recorded from the
11 Galicia Bank by Bañón *et al.*, (2006): one female of 223 mm TL with an attached
12 parasitic male of 29 mm TL (Figure 7), at 762-764 m depth.

13

14 ORDER GOBIESOCIFORMES

15 Family Gobiesocidae

16 **Lepadogaster lepadogaster* (Bonnaterre, 1788) — Shore clingfish

17 **Lepadogaster candolii* Risso, 1810 — Connemarra clingfish

18 **Diplecogaster bimaculata* (Bonnaterre, 1788) — Two-spotted clingfish

19 **Apletodon dentatus* (Facciola, 1887) — Small-headed Clingfish

20

- 1 ORDER ATHERINIFORMES
- 2 Family Atherinidae
- 3 **Atherina presbyter* Cuvier, 1829 — Sand smelt
- 4
- 5 ORDER BELONIFORMES
- 6 Family Scomberesocidae
- 7 *Scomberesox saurus* (Walbaum, 1792) — Saurey pike
- 8 Family Belonidae
- 9 **Belone belone* (Linnaeus, 1761) — Eastern Atlantic garpike
- 10 Family Exocoetidae
- 11 **Cheilopogon heterurus* (Rafinesque, 1810) — Atlantic flying fish
- 12
- 13 ORDER STEPHANOBERYCIFORMES
- 14 Family Melamphaidae
- 15 *Melamphaes microps* (Günther, 1878) — No common name
- 16
- 17 ORDER BERYCIFORMES
- 18 Family Trachichthyidae

- 1 **Hoplostethus mediterraneus* Cuvier, 1829 — Mediterranean slimehead
- 2 *Hoplostethus atlanticus* Collett, 1889 — Orange roughy
- 3 *Hoplostethus cadenati* Quéro, 1974 — Black slimehead
- 4 Family Diretmidae
- 5 *Diretmichthys parini* (Post & Quéro, 1981) — Parin's spiny fin
- 6 Recorded for Galicia based on one unreported specimen caught by the pair-trawl
- 7 "\"Bautista Pino-Nuevo Socio\" (Celeiro) on 2006, at the western of Estaca de Bares Cap
- 8 (Arronte, unpublished data).
- 9 *Diretmus argenteus* Johnson, 1864 — Silver spinyfin
- 10 Family Anoplogasteridae
- 11 *Anoplogaster cornuta* (Valenciennes, 1833) — Common fangtooth
- 12 Family Berycidae
- 13 **Beryx splendens* Lowe, 1834 — Splendid alfonso
- 14 **Beryx decadactylus* Cuvier, 1829 — Beryx
- 15
- 16 ORDER ZEIFORMES
- 17 Family Parazenidae
- 18 *Cyttopsis rosea* (Lowe, 1843) — Rosy dory
- 19 Family Zeidae

- 1 *Zenopsis conchifera* (Lowe, 1852) — Silvery John Dory
- 2 **Zeus faber* Linnaeus, 1758 — John Dory
- 3 Family Oreosomatidae
- 4 *Neocyttus helgae* (Holt & Byrne, 1908) — False boarfish
- 5 Family Caproidae
- 6 **Capros aper* (Linnaeus, 1758) — Boar fish
- 7
- 8 ORDER GASTEROSTEIFORMES
- 9 Family Gasterosteidae
- 10 *Gasterosteus aculeatus* Linnaeus, 1758 — 3-spined stickleback
- 11 **Spinachia spinachia* (Linnaeus, 1758) — 15-spined stickleback
- 12
- 13 ORDER SYNGNATHIFORMES
- 14 Family Fistulariidae
- 15 **Fistularia petimba* Lacepède, 1803 — red cornetfish
- 16 Not mentioned for Galicia by Tortonese in Whitehead *et al.* (1986) nor Quéro *et al.*
- 17 (2003). One specimen of 140 cm TL (Figure 8) caught on 11 May 2006, in Laxe, at the
- 18 north-west coast of Galicia (Bañón & Sande, 2008).
- 19 Family Centriscidae

- 1 **Macroramphosus scolopax* (Linnaeus, 1758) — Snipe-fish
- 2 Family Syngnathidae
- 3 **Hippocampus guttulatus* Cuvier, 1829 — Sea horse
- 4 **Entelurus aequoreus* (Linnaeus, 1758) — Snake pipefish
- 5 **Nerophis lumbriciformis* (Jenyns, 1835) — Worm pipefish
- 6 **Nerophis ophidion* (Linnaeus, 1758) — Straight-nosed pipefish
- 7 *Syngnathus typhle* Linnaeus, 1758 — Deep-snouted pipefish
- 8 *Syngnathus phlegon* Risso, 1827 — No common name
- 9 Not mentioned for Galicia neither by Dawson in Whitehead *et al.* (1986) nor Quéro *et*
- 10 *al.* (2003). Recorded by Lozano y Rey (1947).
- 11 **Syngnathus acus* Linnaeus, 1758 — Great pipefish
- 12 *Syngnathus abaster* Risso, 1827 — Black-striped pipefish
- 13
- 14 ORDER SCORPAENIFORMES
- 15 Family Sebastidae
- 16 **Helicolenus dactylopterus* (Delaroche, 1809) — Blackbelly rosefish
- 17 *Trachyscorpia cristulata* (Koehler, 1896) — Spiny scorpionfish
- 18 Family Scorpaenidae
- 19 *Pontinus kuhlii* (Bowdich, 1825)

- 1 *Scorpaena scrofa* Linnaeus, 1758 — Largescaled scorpionfish
- 2 *Scorpaena porcus* Linnaeus, 1758 — Black scorpionfish
- 3 **Scorpaena notata* Rafinesque, 1810 — Small red scorpionfish
- 4 *Scorpaena loppei* Cadenat, 1943 — Cadenat's rockfish
- 5 Occasional catches between 100-250 m depth in several “Demersales” surveys.
- 6 Family Triglidae
- 7 **Lepidotrigla cavillone* (Lacepède, 1801) — Large-scaled gurnard
- 8 **Lepidotrigla dieuzeidei* Blanc & Hureau, 1973 — Spiny gurnard
- 9 Not mentioned for Galicia neither by Hureau in Whitehead *et al.* (1986) nor Quéro *et al.*
- 10 (2003). Recorded from Galicia by Bañón (2004).
- 11 **Trigla lyra* Linnaeus, 1758 — Piper gurnard
- 12 **Chelidonichthys obscurus* (Bloch & Schneider, 1801) — Longfin gurnard
- 13 **Chelidonichthys lucernus* (Linnaeus, 1758) — Tub gurnard
- 14 *Chelidonichthys lastoviza* (Bonnaterre, 1788) — Streaked gurnard
- 15 **Aspitrigla cuculus* (Linnaeus, 1758) — East Atlantic red gurnard
- 16 **Eutrigla gurnardus* (Linnaeus, 1758) — Grey gurnard
- 17 Family Peristediidae
- 18 **Peristedion cataphractum* (Linnaeus, 1758) — African armoured searobin
- 19 Family Cottidae

- 1 **Taurulus bubalis* (Euphrasen, 1786) — Longspined bullhead
- 2 Family Psychrolutidae
- 3 *Cottunculus thomsonii* (Günther, 1882) — Pallid sculpin
- 4 Family Cyclopteridae
- 5 **Cyclopterus lumpus* Linnaeus, 1758 — Lumpsucker
- 6 A boreal species occasionally present in Galician waters (Figure 9), mainly during the
- 7 first semester of the year, when a migration to shallow waters for reproduction takes
- 8 place (Bañón *et al.* 2008).
- 9 Family Liparidae
- 10 *Liparis montagui* (Donovan, 1804) — Montagu’s sea snail
- 11 *Paraliparis membranaceus* Günther, 1887 — No common name
- 12 Occasional catches between 500-700 m depth in several “Demersales” surveys.
- 13
- 14 ORDER PERCIFORMES
- 15 Family Moronidae
- 16 **Dicentrarchus labrax* (Linnaeus, 1758) — European seabass
- 17 Family Polyprionidae
- 18 *Polyprion americanus* (Bloch & Schneider, 1801) — Wreckfish
- 19 Family Serranidae

- 1 **Anthias anthias* (Linnaeus, 1758) — Swallowtail seaperch
- 2 *Epinephelus marginatus* (Lowe, 1834) — Dusky grouper
- 3 *Serranus scriba* (Linnaeus, 1758) — Painted comber
- 4 Reported by De Buen (1935b); there are no posterior records of this species.
- 5 **Serranus cabrilla* (Linnaeus, 1758) — Comber
- 6 Family Callanthiidae
- 7 **Callanthias ruber* (Rafinesque, 1810) — Parrot seaperch
- 8 Family Epigonidae
- 9 *Epigonus telescopus* (Risso, 1810) — Bulls-eye
- 10 Family Pomatomidae
- 11 *Pomatomus saltatrix* (Linnaeus, 1766) — Bluefish
- 12 Not mentioned for Galician waters by Tortonese in Whitehead *et al.* (1986). Recorded
- 13 by Lozano y Rey (1952), based on a picture of one specimen in the port of Vigo,
- 14 erroneously identified by De Buen (1935b). There are reports of sporadic catches by
- 15 game fishers from 1969 to approximately 1994. The last specimen of 76 cm TL was
- 16 caught on 3 June 2007 in Portosin (Bañón *et al.*, 2008).
- 17 Family Echeneidae
- 18 *Remora brachyptera* (Lowe, 1839) — Spearfish remora
- 19 Not mentioned for Galician waters neither by Lachner in Whitehead *et al.* (1986) nor
- 20 Quéro *et al.*, (2003). Recorded from Galicia by Solórzano *et al.* (1988), as specimens

1 attached to swordfish individuals caught by the longliners. We consider this a doubtful
2 record, probably out of the study area.

3 **Remora remora* (Linnaeus, 1758) — Common remora

4 Two specimens of 10 and 11 cm TL caught during the survey “Demersales 00” at 267
5 m depth.

6 Family Carangidae

7 **Trachurus trachurus* (Linnaeus, 1758) —Atlantic horse mackerel

8 **Trachurus picturatus* (Bowdich, 1825) — Blue jack mackerel

9 *Trachurus mediterraneus* (Steindachner, 1868) — Mediterranean horse mackerel

10 *Pseudocaranx dentex* (Bloch & Schneider, 1801) — White trevally

11 Not mentioned for Galician waters by Smith-Vaniz in Whitehead *et al.* (1986).
12 Reported by Fernández and Bañón (1997).

13 *Caranx crysos* (Mitchill, 1815) — Blue runner

14 Not mentioned for Galician waters by Smith-Vaniz in Whitehead *et al.* (1986).
15 Recorded from Galicia by Bañón and Casas (1997). A new unreported specimen of 52
16 cm TL was caught on 30th November 2009 in the Ensenada de Corcubión, at 33 m
17 depth (Figure 10).

18 **Naucrates ductor* (Linnaeus, 1758) —Pilotfish

19 **Seriola rivoliana* Valenciennes, 1833—Almaco jack

20 **Seriola fasciata* (Bloch, 1793) — Lesser amberjack

- 1 Not mentioned for Galician waters neither by Smith-Vaniz in Whitehead *et al.* (1986)
2 nor Quéro *et al.* (2003). Recorded from Galicia by Bañón and Mucientes (2009), one
3 specimen of 32 cm TL caught on 19th September 2008 in the Ría de Arousa (South
4 Galicia) at 12 m depth.
- 5 *Campogramma glaycos* (Lacepède, 1801) —Vadigo
- 6 *Lichia amia* (Linnaeus, 1758) — Leerfish
- 7 *Trachinotus ovatus* (Linnaeus, 1758) — Derby
- 8 Family Coryphaenidae
- 9 *Coryphaena hippurus* Linnaeus, 1758 — Common dolphinfish
- 10 *Coryphaena equiselis* Linnaeus, 1758 — Pompano dolphinfish
- 11 Family Bramidae
- 12 *Pterycombus brama* Fries, 1837 — Atlantic fanfish
- 13 **Taractes asper* Lowe, 1843 — Rough pomfret
- 14 *Taractichthys longipinnis* (Lowe, 1843) — Bigscale pomfret
- 15 **Brama brama* (Bonnaterre, 1788) — Atlantic pomfret
- 16 Family Sparidae
- 17 *Dentex gibbosus* (Rafinesque, 1810) — Pink dentex
- 18 Reported by López-Seoane (1866); there are no posterior records of this species.
- 19 *Dentex macrophthalmus* (Bloch, 1791) — Large-eye dentex

- 1 *Dentex dentex* (Linnaeus, 1758) —Common dentex
- 2 *Pagrus caeruleostictus* (Valenciennes, 1830) — Bluespotted seabream
- 3 Reported by Fernández *et al.* (1978) as *Sparus caurelosticus*.
- 4 **Pagrus pagrus* (Linnaeus, 1758) — Common seabream
- 5 *Diplodus annularis* (Linnaeus, 1758) — Annular seabream
- 6 **Diplodus cervinus* (Lowe, 1838) — Zebra seabream
- 7 **Diplodus sargus* (Linnaeus, 1758) — White seabream
- 8 **Diplodus vulgaris* (Geoffroy Saint-Hilaire, 1817) — Common two-banded seabream
- 9 *Diplodus puntazzo* (Cetti, 1777) — Sharpsnout seabream
- 10 **Pagellus acarne* (Risso, 1827) — Axillary seabream
- 11 **Pagellus bogaraveo* (Brünnich, 1768) — Blackspot seabream
- 12 **Pagellus erythrinus* (Linnaeus, 1758) — Common pandora
- 13 **Sparus aurata* Linnaeus, 1758 — Gilthead seabream
- 14 **Boops boops* (Linnaeus, 1758) — Bogue
- 15 *Oblada melanura* (Linnaeus, 1758) — Saddled seabream
- 16 **Sarpa salpa* (Linnaeus, 1758) — Salema
- 17 **Spondyllosoma cantharus* (Linnaeus, 1758) — Black seabream
- 18 **Lithognathus mormyrus* (Linnaeus, 1758) — Striped seabream

- 1 Family Centranchidae
- 2 *Spicara maena* (Linnaeus, 1758) — Blotched picarel
- 3 Reported by López-Seoane (1866); there are no posterior records of this species.
- 4 Family Sciaenidae
- 5 *Umbrina cirrosa* (Linnaeus, 1758) — Shi drum
- 6 *Sciaena umbra* Linnaeus, 1758 — Brown meagre
- 7 *Umbrina canariensis* Valenciennes, 1843 — Canary drum
- 8 Recorded for Galicia based on one specimen of 369 mm TL caught on 11 March 2009
- 9 in the Ría de Viveiro.
- 10 *Argyrosomus regius* (Asso, 1801) — Meagre
- 11 Family Mullidae
- 12 **Mullus surmuletus* Linnaeus, 1758 — Striped red mullet
- 13 *Mullus barbatus barbatus* Linnaeus, 1758 — Red mullet
- 14 Family Kyphosidae
- 15 *Kyphosus sectator* (Linnaeus, 1758) — Bermuda sea chub
- 16 Not mentioned for the Atlantic European waters neither by Tortonese in Whitehead *et*
- 17 *al.* (1986) nor Quéro *et al.* (2003). Recorded from Galicia by Bañón (2004) (Figure 11)
- 18 but previously watched by scuba divers, at least since 2001. There are also three
- 19 posterior records of this species.

- 1 Family Cepolidae
- 2 **Cepola macrophthalmia* (Linnaeus, 1758) — Red bandfish
- 3 Family Mugilidae
- 4 **Chelon labrosus* (Risso, 1827) — Thicklip grey mullet
- 5 *Mugil cephalus* Linnaeus, 1758 — Flathead mullet
- 6 **Liza aurata* (Risso, 1810) — Golden grey mullet
- 7 *Liza ramado* (Risso, 1810) — Thinlip mullet
- 8 Family Labridae
- 9 **Coris julis* (Linnaeus, 1758) — Mediterranean rainbow wrasse
- 10 **Acantholabrus palloni* (Risso, 1810) — Scale-rayed wrasse
- 11 **Centrolabrus exoletus* (Linnaeus, 1758) — Rock cook
- 12 **Labrus bergylta* Ascanius, 1767 — Ballan wrasse
- 13 **Labrus mixtus* Linnaeus, 1758 — Cuckoo wrasse
- 14 *Labrus merula* Linnaeus, 1758 — Brown wrasse
- 15 Reported by López-Seoane (1866); there are no posterior records of this species.
- 16 *Labrus viridis* Linnaeus, 1758 — Green wrasse
- 17 Reported by López-Seoane (1866); there are no posterior records of this species.
- 18 **Ctenolabrus rupestris* (Linnaeus, 1758) — Goldsinny

- 1 **Symphodus bailloni* (Valenciennes, 1839) — Baillon's wrasse
- 2 **Symphodus cinereus* (Bonnaterre, 1788) — Grey wrasse
- 3 *Symphodus tinca* (Linnaeus, 1758) — East Atlantic peacock wrasse
- 4 **Symphodus melops* (Linnaeus, 1758) — Corkwing
- 5 *Symphodus ocellatus* (Forsskål, 1775) — No common name
- 6 Family Chiasmodontidae
- 7 *Chiasmodon niger* Johnson, 1864 — Black swallower
- 8 Family Ammodytidae
- 9 **Gymnammodytes semisquamatus* (Jourdain, 1879) — Smooth sandeel
- 10 **Ammodytes tobianus* Linnaeus, 1758 — Sandeel
- 11 **Hyperoplus lanceolatus* (Le Sauvage, 1824) — Great sandeel
- 12 *Hyperoplus immaculatus* (Corbin, 1950) — Immaculate sandeel
- 13 Not mentioned for Galician waters neither by Reay in Whitehead *et al.* (1986) nor Quéro
- 14 *et al.* (2003). Recorded from Galicia by Franco and Sola (1985).
- 15 Family Trachinidae
- 16 **Trachinus draco* Linnaeus, 1758 — Greater weever fish
- 17 **Echiichthys vipera* (Cuvier, 1829) — Lesser weever fish
- 18 *Trachinus araneus* Cuvier, 1829 — Spotted weever

- 1 Identified by a photo of one specimen captured by gill-net in May 2008 in the Ría de
- 2 Muros (Figure 12).
- 3 Family Uranoscopidae
- 4 *Uranoscopus scaber* Linnaeus, 1758 — Atlantic stargazer
- 5 Family Tripterygiidae
- 6 **Tripterygion delaisi* Cadenat & Blache, 1971 — Black-faced blenny
- 7 Family Blenniidae
- 8 **Parablennius ruber* (Valenciennes, 1836) — Portuguese blenny
- 9 **Parablennius gattorugine* (Brünnich, 1768) — Tompot blenny
- 10 **Parablennius sanguinolentus* (Pallas, 1811) — Rusty blenny
- 11 **Parablennius pilicornis* (Cuvier, 1829) — Ringneck blenny
- 12 **Salaria pavo* (Risso, 1810) — Peacock blenny
- 13 **Coryphoblennius galerita* (Linnaeus, 1758) — Montagu's blenny
- 14 **Blennius ocellaris* Linnaeus, 1758 — Butterfly blenny
- 15 **Lipophrys pholis* (Linnaeus, 1758) — Shanny
- 16 **Paralipophrys trigloides* (Valenciennes, 1836) — No common name
- 17 Family Callionymidae
- 18 **Callionymus lyra* Linnaeus, 1758 — Common dragonet
- 19 **Callionymus maculatus* Rafinesque-Schmaltz, 1810 — Spotted dragonet

- 1 **Callionymus reticulatus* Valenciennes, 1837 — Reticulate dragonet
- 2 Family Gobiidae
- 3 *Crystallogobius linearis* (Düben, 1845) — Crystal goby
- 4 **Gobius niger* Linnaeus, 1758 — Black goby
- 5 **Gobius paganellus* Linnaeus, 1758 — Rock Goby
- 6 **Gobius cobitis* Pallas, 1814 — Giant goby
- 7 *Gobius cruentatus* Gmelin 1789 — Red-mouthed goby
- 8 **Gobius xanthocephalus* Heymer and Zander, 1992 — No common name
- 9 Recorded by De Buen (1918, 1935) and Iglesias (1981) as *G. auratus*. Recent studies
- 10 have confirmed that the ancient records are in fact *G. xanthocephalus* (Figure 13)
- 11 (Villegas-Ríos and Bañón, in press).
- 12 *Gobius gasteveni* Miller, 1974 — Steven's goby
- 13 Not recorded from Galicia neither by Miller in Whitehead *et al.* (1986) nor Quéro
- 14 (2003). However it is recorded from Galicia by Alberto *et al.* (1999). Although it is
- 15 seldom caught by fishery gears, it is ususally observed by scuba divers in the Rías
- 16 Baixas of Galicia where it is a common species (Figure 14).
- 17 *Gobiusculus flavescens* (Fabricius, 1779) — Two-spotted goby
- 18 **Aphia minuta* (Risso, 1810) — Transparent goby
- 19 *Lesueurigobius suerii* (Risso, 1810) — Lesueur's goby
- 20 **Lesueurigobius friesii* (Malm, 1874) — Fries's goby

- 1 **Deltentosteus quadrimaculatus* (Valenciennes, 1837) — Four-spotted goby
- 2 **Pomatoschistus minutus* (Pallas, 1770) — Sand goby
- 3 **Pomatoschistus microps* (Kroyer, 1838) — Common goby
- 4 *Pomatoschistus norvegicus* (Collett, 1902) — Norwegian goby
- 5 Not recorded from Galicia neither by Miller in Whitehead *et al.* (1986) nor Quéro
- 6 (2003). Reported by De Buen (1935b) as *P. fagei*. A total of 11 specimens were
- 7 captured again between 140-180 m depth in “Demersales 86” and “Demersales 01”
- 8 surveys.
- 9 **Pomatoschistus pictus* (Malm, 1865) — Painted goby
- 10 *Pomatoschistus lozanoi* (De Buen, 1923) — Lozano's goby
- 11 *Zosterisessor ophiocephalus* (Pallas, 1814) — Grass goby
- 12 Not recorded from Galicia neither by Miller in Whitehead *et al.* (1986) nor by Quéro
- 13 (2003). Reported by De Buen (1935b); we consider this a doubtful record.
- 14 *Thorogobius ephippiatus* (Lowe, 1839) — Leopard-spotted goby
- 15 Unrecorded from Galicia but many underwater images confirm their presence (Figure
- 16 15).
- 17 Family Luvaridae
- 18 *Luvarus imperialis* Rafinesque, 1810 — Luvar
- 19 Family Scombrolabracidae
- 20 *Scombrolabrax heterolepis* Roule, 1921 — Longfin escolar

- 1 Family Sphyraenidae
- 2 *Sphyraena sphyraena* (Linnaeus, 1758) — European barracuda
- 3 Family Gempylidae
- 4 *Nesiarchus nasutus* Johnson, 1862 — Black gemfish
- 5 *Ruvettus pretiosus* Cocco, 1833 — Oilfish
- 6 Family Trichiuridae
- 7 *Trichiurus lepturus* Linnaeus, 1758 — Largehead hairtail
- 8 **Lepidopus caudatus* (Euphrasen, 1788) — Scabbard fish
- 9 *Aphanopus carbo* Lowe, 1839 — Black scabbardfish
- 10 *Benthodesmus simonyi* (Steindachner, 1891) — Simony's frostfish
- 11 Family Xiphiidae
- 12 *Xiphias gladius* Linnaeus, 1758 — Swordfish
- 13 Family Istiophoridae
- 14 *Tetrapturus albidus* Poey, 1860 — Atlantic white marlin
- 15 Family Scombridae
- 16 *Scomber colias* Gmelin, 1789 — Chub mackerel
- 17 **Scomber scombrus* Linnaeus, 1758 — Atlantic mackerel
- 18 *Thunnus thynnus* (Linnaeus, 1758) — Blue-fin tunny

- 1 *Thunnus alalunga* (Bonnaterre, 1788) — Albacore
- 2 *Katsuwonus pelamis* (Linnaeus, 1758) — Skipjack tuna
- 3 *Auxis rochei* (Risso, 1810) — Frigate mackerel
- 4 *Sarda sarda* (Bloch, 1793) — Bonito
- 5 Family Centrolophidae
- 6 **Centrolophus niger* (Gmelin, 1789) — Blackfish
- 7 Family Nomeidae
- 8 *Cubiceps gracilis* (Lowe, 1843) — Driftfish
- 9 Family Stromateidae
- 10 *Stromateus fiatola* Linnaeus, 1758— Blue butterflyfish
- 11
- 12 ORDER PLEURONECTIFORMES
- 13 Family Citharidae
- 14 *Citharus linguatula* (Linnaeus, 1758) — Atlantic spotted flounder
- 15 Recorded for Galicia based on 15 specimens ranging between 6 and 10 cm TL caught at
- 16 130-160 m depth during several “Demersales” surveys.
- 17 Family Scophthalmidae
- 18 **Scophthalmus rhombus* (Linnaeus, 1758) — Brill
- 19 **Psetta maxima* (Linnaeus, 1758) — Turbot

- 1 **Zeugopterus punctatus* (Bloch, 1787) — Topknot
- 2 **Zeugopterus regius* (Bonnaterre, 1788) — Eckström's topknot
- 3 **Phrynorhombus norvegicus* (Günther, 1862) — Norwegian topknot
- 4 Not recorded from Galicia neither by Nielsen in Whitehead *et al.* (1986) nor Quéro
- 5 (2003). However it is recorded by Iglesias (1981) and posteriorly by Bañón *et al.*
- 6 (2008b) (Figure 16), confirming its presence in Galician waters and extending to the
- 7 south of its distribution range.
- 8 *Lepidorhombus boscii* (Risso, 1810) — Fourspotted megrim
- 9 *Lepidorhombus whiffiagonis* (Walbaum, 1792) — Megrim
- 10 Family Bothidae
- 11 **Arnoglossus imperialis* (Rafinesque, 1810) — Imperial scald fish
- 12 **Arnoglossus thori* Kyle, 1913 — Thor's scaldfish
- 13 **Arnoglossus laterna* (Walbaum, 1792) — Scald fish
- 14 Family Pleuronectidae
- 15 *Microstomus kitt* (Walbaum, 1792) — Lemon sole
- 16 Recorded for Galicia based on two specimens of 43 cm TL caught at 96 and 96.5 m
- 17 depth during the surveys “Demersales 95” and “Demersales 96” respectively.
- 18 **Platichthys flesus* (Linnaeus, 1758) — Flounder
- 19 **Pleuronectes platessa* Linnaeus, 1758 — European plaice

- 1 *Glyptocephalus cynoglossus* (Linnaeus, 1758) — Witch
- 2 Family Soleidae
- 3 *Microchirus azevia* (de Brito Capello, 1867) — Bastard sole
- 4 **Microchirus variegatus* (Donovan, 1808) — Thickback sole
- 5 *Monochirus hispidus* Rafinesque, 1814 — Whiskered sole
- 6 Reported by López-Seoane (1866); there are no posterior records of this species.
- 7 **Solea solea* (Linnaeus, 1758) — Sole
- 8 *Solea senegalensis* Kaup, 1858 — Senegalese sole
- 9 **Pegusa lascaris* (Risso, 1810) — Sand sole
- 10 **Bathysolea profundicola* (Vaillant, 1888) — Deepwater sole
- 11 *Dicologlossa cuneata* (Moreau, 1881) — Wedge sole
- 12 **Buglossidium luteum* (Risso, 1810) — Solenette
- 13 Family Cynoglossidae
- 14 *Symphurus nigrescens* Rafinesque, 1810 — Tonguesole
- 15
- 16 ORDER TETRAODONTIFORMES
- 17 Family Balisitidae
- 18 *Balistes capriscus* Gmelin, 1789 — Grey trigger fish

Family Tetraodontidae

Lagocephalus lagocephalus (Linnaeus, 1758) — Puffer fish

Lagocephalus laevis (Linnaeus, 1758) — Smooth puffer

Not mentioned for Galicia neither by Tortonese in Whitehead *et al.* (1986) nor Quéro *et al.* (2003). Known by a single specimen of 51 cm TL (Figure 17) caught in July 2009 in the Cies Islands, in the mouth of the Ría de Vigo (South Galicia) (Bañón & Santás, in press).

Family Diodontidae

Diodon hystrix Linnaeus, 1758 — Spot-fin porcupinefish

Family Molidae

Mola mola (Linnaeus, 1758) — Sunfish

Ranzania laevis (Pennant, 1776) — Truncated sunfish

Discussion

Since the 16th century, Galicia has kept a long tradition in fish fauna studies, whose results however have had scarce divulgation beyond our frontiers, probably as a result of a limited dissemination and a relative isolation of the local researchers.

The present checklist includes 398 species of marine fishes from Galicia which represents approximately 42 % of the 955 species listed for European Atlantic waters by Quéro *et al.* (2003).

1 The European Atlantic coast has a sharp north to south temperature gradient,
2 which restricts the distribution of many species and leads to a biogeographic
3 subdivision of the eastern Atlantic into two provinces: the boreal Atlantic and the
4 subtropical Lusitanian. The Lusitanian province, which extends from Gibraltar to
5 Brittany, has been subdivided in two sub-provinces, whose frontier was established in
6 Finisterre Cap, in the western Galician coast. Thus, the fauna of Galicia are mixed with
7 groups of boreal and subtropical origin. This fact, together with the variety of coastal
8 habitats of the study area (such as rocky cliffs, shingle, rocky, sandy and muddy shores,
9 coastal lagoons and estuaries) is behind the observed diversity of many faunal groups in
10 Galicia, including marine fishes.

11 The Galician Atlantic coast constitutes the northernmost limit of the Eastern
12 North Atlantic Upwelling System. Upwelling favourable winds prevail from March to
13 October and cause the entry of great flows of North Atlantic Central Water, a salty cold
14 water mass (Álvarez-Salgado et al., 1993). Upwelling is intensified off Cape Finisterre
15 and the Rias Baixas, where water temperature is sensibly lower in comparison with the
16 northern Galician coast and the Bay of Biscay. These surface waters, colder than the
17 surrounding ocean, are probably the reason behind the biogeographical anomaly found
18 in the distribution of some fish in the Atlantic Galician coasts. As a result, cool water
19 species, well represented to the south of the British Isles, are newly present in Galicia,
20 about all in the western of Galicia, from A Guarda to Finisterre Cap (Rías Baixas), but
21 scarce or absent in the northern coast and the Bay of Biscay. This is the case for
22 example of *G. morhua*, *G. cynoglossus* and *P. norvegicus*, among others. In the same
23 way, warm water species that are scarce or absent in the Atlantic front of Galicia are
24 present in the coast of Lugo (north Galicia) and in the Bay of Biscay. This is the case
25 for example of several sparids such as *L. mormyrus* or *D. cervinus*.

1 This traditional distribution pattern seems to have been altered in the last
2 decades with the arrival of numerous southern tropical fish species to the Galician
3 coasts, probably linked to global warming. The inexistence of a previous specific
4 monitoring program prevents us to know the origin of this trend. The first two species
5 related with this phenomenon were probably the grey triggerfish *B. carolinensis* and the
6 flatfish *S. senegalensis*, previously unknown and now with a relevant biomass in
7 Galician waters. Since 1996, increasing monitoring, divulgation and contact to the
8 fishing sector have led to register numerous tropical affinity species in Galicia, most of
9 them setting a new northern limit of distribution for the NE Atlantic.

10 Community studies in regions of overlapping ‘polar’ and ‘temperate’ species, as
11 it’s the case of Galicia, base their climate change attribution on differential responses of
12 these two categories. Among polar marine fish species have tended to be stable or
13 decline in abundance, whereas temperate species at the same site have increased in
14 abundance and/or expanded their distributions (Parmesan & Yohe, 2003).

15 The last studies in Galicia seem to confirm this hypothesis (Bañón, 2009). Colder
16 species such as *P. flesus* have decreased their catches in the last decades whereas warm
17 species have increased considerably their number and biomass. Carangids increased
18 from four species at the beginning of the 20th century to eleven in the present days, due
19 to the arrival of several tropical species such as *C. crysos*, *P. dentex* and *S. fasciata*.

20 Another carangid, *T. picturatus* has greatly increased its abundance in very few
21 years, and has become a commercially important species. Rare species of the genus
22 *Seriola*, mainly *S. rivoliana* and other unexpected species such as *S. sphyraena* and *K.*
23 *sectator* are becoming more and more frequent. Finally, surprising tropical species such
24 as *F. petimba* and *L. laevigatus* have been recently recorded. All these new records

represent in fact a tropicalization of the marine fish fauna of Galicia, what in our opinion confirms this hypothesis.

Biogeographical analysis revealed that the Lusitanian group included 204 species (51.3%), followed by 149 species of the Atlantic (37.4%), the 28 species of the Boreal (7%), and 17 species (4.3%) of the African group. While Boreal species are in general terms well known since a long time ago, the knowledge of the African group is very recent, mainly due to the arrive of new species during the last decades. This fact also supports the idea that the recent discovery of tropical species of African origin is more a consequence of natural changes than a result of an increased in the sampling effort.

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References

- 1 Álvarez-Salgado, X.A., Rosón, G., Pérez, F.F. & Pazos, Y. (1993) Hydrographic
2 variability off the Rias Baixas (NW Spain) during the upwelling season. *Journal of*
3 *Geophysical Research*, 98 (C8),14447–14455.
- 4 Anadón, E. (1957) Anatomía e histología de las placas luminosas caudales de
5 *Lampadena nitida*. *Boletín Real Sociedad Española de Historia Natural*, 55 (1), 129-
6 143.
- 7 Arté, P (1952) Peces raros de los grandes fondos de las aguas gallegas. *Industrias*
8 *Pesqueras*, 625 (6), 48-51.
- 9 Alberto L. J., Nieto, P. & Rodriguez Solorzano, M. (1999) Live coloration and diet of
10 *Gobius gasteveni* (Teleostei: Gobiidae), with a first record from continental Europe.
11 *Cahiers de Biologie Marine*, 40, 77-85.
- 12 Bañón, R. & Casas, J.M. (1997) Primera cita de *Caranx crysos* (Mitchill, 1815) para
13 aguas de Galicia. *Boletín del Instituto Español de Oceanografía*, 13 (1 y 2), 79-81.
- 14 Bañón, R., Casas, J.M, Piñeiro, C.G. & Coveló, M. (1997) Capturas de peces de
15 afinidades tropicales en aguas atlánticas de Galicia (NO de la península Ibérica). *Boletín*
16 *del Instituto Español de Oceanografía*, 13 (1 y 2), 57-66
- 17 Bañón, R. (2002) Actualización del listado faunístico de peces de mar de Galicia. *Nova*
18 *Acta Científica Compostelana*, 12, 119-123.
- 19 Bañón, R., Del Río, J.L., Piñeiro, C. & Casas, M. (2002) Occurrence of Tropical
20 Affinity Fishes In Galician Waters NW Spain. *Journal of the Marine Biology*
21 *Association of the United Kingdom*, 82, 877-880.

- 1 Bañón, R. (2004) New records of two southern fish in Galician waters (NW Spain).
2 *Cybium*, 28 (4), 367-368.
- 3 Bañón, R., Pietsch, T.W. & Piñeiro, C-G. (2006) New record of *Linophryne coronata*,
4 (Lophiiformes, Linophrynidae) from the North-Eastern Atlantic Ocean. *Cybium*, 30 (4),
5 385-386.
- 6 Bañón, R. & Garazo, A. (2006). Presencia de medregal negro *Seriola rivoliana*
7 Valenciennes, 1833 y barracuda *Sphyraena sphyraena* (Linnaeus, 1758) (Perciformes)
8 en la costa de Galicia. *Nova Acta Científica Compostelana (Biología)*, 15, 95-97.
- 9 Bañón, R & Sande, C. (2008) First record of the cornetfish *Fistularia petimba*
10 (Syngnathiformes: Fistularidae) from Galician waters. A northernmost occurrence in the
11 Eastern Atlantic. *Journal of Applied Ichthyology*, 24, 106–107.
- 12 Bañón, R., Garazo, A. & Fernández, A. (2008). Note about the presence of the
13 lumpsucker *Cyclopterus lumpus* (Teleostei, Cyclopteridae) in Galician waters (NW
14 Spain). *Journal of Applied Ichthyology*, 24, 108-109.
- 15 Bañón, R., Cerdeira, J.D., Ferreiro, P. & Sande, C.M. (2007). Nuevas aportaciones a la
16 ictiofauna marina de Galicia. *Nova Acta Científica Compostelana (Biología)*, 16, 161-
17 163.
- 18 Bañón, R., Ferreiro, P., García-Seoane, E., Oliver, P. & Ínsua, J. (2008). Nuevos datos
19 sobre la presencia de especies nuevas o poco conocidas de la ictiofauna marina de
20 Galicia (II). *Nova Acta Científica Compostelana (Biología)*, 17, 191-194.
- 21 Bañón, R. (2009) Variacións na diversidade e abundancia ictiolóxica mariña en Galicia
22 por efectos do cambio climático. *In*: Xunta de Galicia. Consellería de Medio Ambiente

e Desenvolvimento Sostible (Ed.), *Evidencias e impactos do cambio climático en Galicia*, 18, 355-371.

Bañón, R. & Mucientes, G.R. (2009) First record of *Seriola fasciata* (Carangidae) from Galician waters (NW Spain). A new northernmost occurrence in the NE Atlantic. *Cybium*, 33 (3), 247-248.

Cornide, J. (1788) *Ensayo de una historia de los peces y otras producciones marinas de la costa de Galicia*. Edición facsímile, estudo preliminar por V. Paz-Andrade. Edicións do Castro, 1983. 263 pp.

De Buen, F. (1918) Los góbidos de la península Ibérica y Baleares. *Boletín de Pesca*, 26, 291-337.

De Buen, F. (1935a) Fauna ictiológica. Catálogo de los peces ibéricos de la planicie continental, aguas dulces, pelágicos y de los abismos próximos. I parte. *Notas y Resúmenes del Instituto Español de Oceanografía*, 82, 1-89.

De Buen, F. (1935b) Fauna ictiológica. Catálogo de los peces ibéricos de la planicie continental, aguas dulces, pelágicos y de los abismos próximos. II parte. *Notas y Resúmenes del Instituto Español de Oceanografía*, 82, 89-148.

Ellis, J.R., Engelhard, G.H. & Pinnegar, J.K. (2007) Ecotypology of fishes in the eastern North Atlantic. *RECLAIM*, 26: 68 p. Available from: <http://www.climateandfish.eu> (accessed 12/04/2010).

- 1 Fernández, A., Pereiro, F.X., Iglesias, S., Porteiro, C. & Pallarés, P. (1978) La
2 Pesquería demersal gallega, estrategias de pesca para su regulación racional en base a la
3 merluza. *Boletín del Instituto Español de Oceanografía*, 4(249), 69-109.
- 4 Fernández C.A. & Bañón, R. (1997) Primera cita del Jurel dentón *Pseudocaranx dentex*
5 (Bloch & Schneider in Schneider, 1801) en aguas de Galicia (noroeste Ibérico). *Boletín*
6 *del Instituto Español de Oceanografía*, 13 (1 y 2), 87-90.
- 7 Franco, C. & Sola, A. (1985) Estudios de ictioplancton de especies de interes comercial
8 de la plataforma gallega. *Boletín del Instituto Español de Oceanografía*, 2(3), 15-26.
- 9 Froese, R. and Pauly, D. (2010) *FishBase*. Available from: www.fishbase.org (accessed
10 25/01/2010).
- 11 Iglesias, J. (1981) Spatial and temporal changes in the demersal fish community of the
12 Ría de Arosa (NW Spain). *Marine Biology*, 65(2), 199-208.
- 13 López-Seoane, V. (1866) *Reseña de la historia natural de Galicia*. Edición facsímil,
14 Edición do Castro, 1996. Sada, A Coruña. 66 pp.
- 15 Lozano y Rey, L. (1947) Peces Ganoideos y Fisóstomos. *Memorias de la Real*
16 *Academia de Ciencias Exactas, Físicas y Naturales de Madrid. Serie Ciencias*
17 *Naturales*, 11: 1-839.
- 18 Lozano y Rey, L. (1952) Peces fisoclistos, Subserie Toracicos. *Memorias de la Real*
19 *Academia de Ciencias Exactas, Físicas y Naturales de Madrid. Serie Ciencias*
20 *Naturales*., Primera parte, 14:1-378; Segunda parte, 14: 379-705.

- 1 Piñeiro, C, Casas, J.M; Bañón, R., Serrano, A. & Calviño, A. (1996) Resultados de la
2 acción piloto de pesca experimental en el talud de la plataforma gallega (noroeste de la
3 península ibérica). *Datos y Resúmenes del Instituto Español de Oceanografía*, 1-57.
- 4 Parmesan, C. & Yohe, G. (2003) A globally coherent fingerprint of climate change
5 impacts across natural systems. *Nature*, 421, 37-42.
- 6 Quéro J.-C., Porche P. & Vayne, J.-J (2003) *Guide des poissons de l'Atlantique*
7 *Européen*, Delachaux & Niestlé Ed., 465 pp.
- 8 Solórzano, M. R.; Devesa, S. & Soutullo, L. (1983). *Guía dos peixes de Galicia*. Ed.
9 Galaxia, Vigo, 224 pp.
- 10 Solórzano, M.R., Rodríguez, J.L., Iglesias, J., Pereiro, F.X. & Álvarez, F. (1988)
11 *Inventario dos Peixes do Litoral Galego (Pisces: Cyclostomata, Chondrichthyes,*
12 *Osteichthyes)*. Cadernos da área de Ciencias Biolóxicas, (Inventarios). Seminario de
13 Estudos Galegos, Vol IV. Ed. Do Castro, O Castro-Sada, A Coruña, 69 pp.
- 14 Villegas-Ríos, D. & Bañón, R. (in press) First record and new meristic data of *Gobius*
15 *xanthocephalus* (Gobiidae) from Galician waters (NW Spain). *Cybium*.
- 16 Whitehead, P.J.P., Bauchot, M.L., Hureau, J.C., Nielsen, J. & Tortonese, E. (1984–
17 1986) Fishes of the North-Eastern Atlantic and the Mediterranean. 3 vol. UNESCO,
18 Paris, 1473 pp.
- 19

Figure 1. Map of the study area

Figure 2. *Pseudotriakis microdon* (photo R. Bañón).

Figure 3. *Pisodonophis semicinctus* (photo R. Bañón).

Figure 4. *Physiculus dalwigki* (photo R. Bañón).

Figure 5. *Gaidropsarus granti* (photo R. Bañón).

Figure 6. *Ceratias holboelli* (photo R. Bañón).

Figure 7. *Lynophryne coronata* (photo R. Bañón).

Figure 8. *Fistularia petimba* (photo C. Sande).

Figure 9. *Cyclopterus lumpus* (photo R. Bañón).

Figure 10. *Caranx crysos*. (photo R. Bañón).

Figure 11. *Kyphosus sectator* (photo R. Bañón).

Figure 12. *Trachinus araneus* (photo UTPB-Xunta de Galicia).

Figure 13. *Gobius xantocephalus* (photo D. Villegas-Ríos).

Figure 14. *Gobius gasteveni* (photo D. Villegas-Ríos).

Figure 15. *Thorogobius ephippiatus* (photo D. Villegas-Ríos).

Figure 16. *Phrynorhombus norvegicus* (photo R. Bañón).

Figure 17. *Lagocephalus laevigatus* (photo R. Bañón).

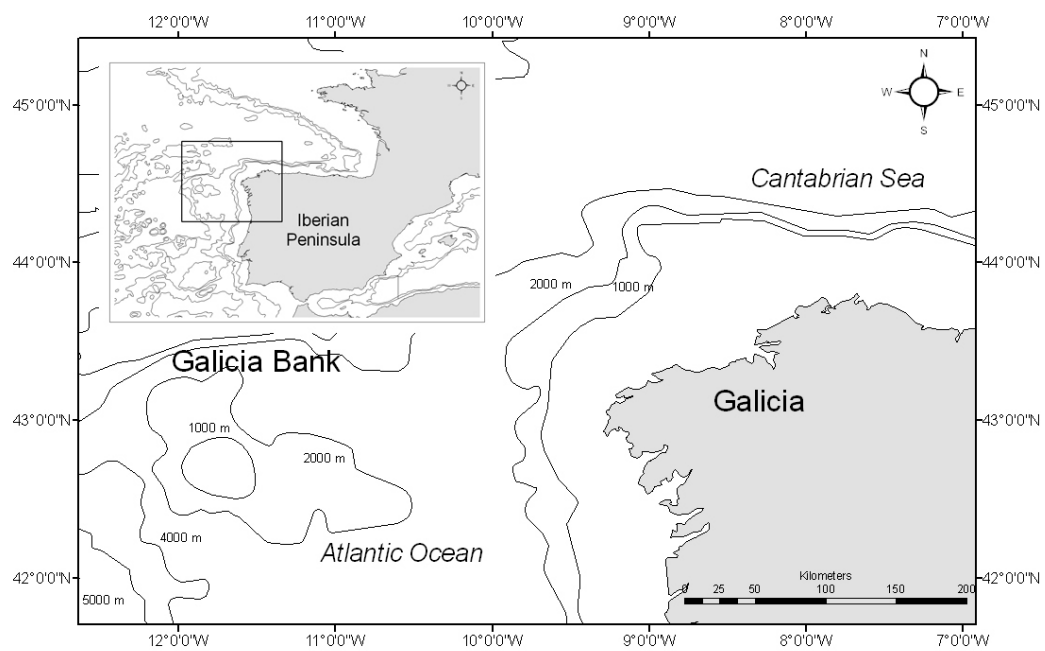


Figure 1



Figure 2



Figure 3

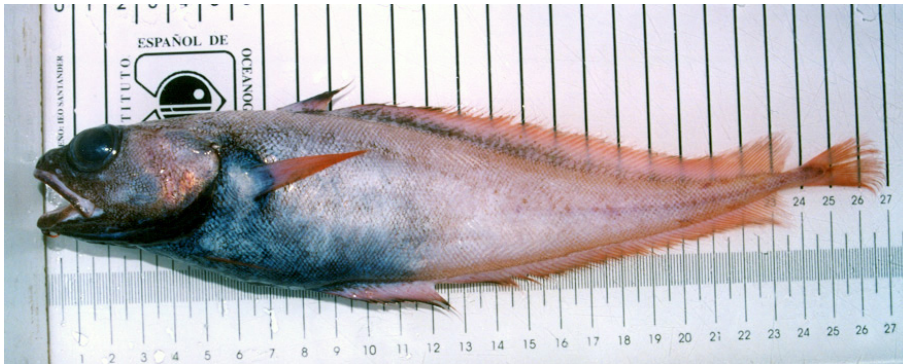


Figure 4



Figure 5



Figure 6



Figure 7



Figure 8



Figure 9



Figure 10



Figure 11



Figure 12



Figure 13



Figure 14



Figure 15



Figure 16



Figure 17